

Learning Objectives

Students will practice skills with a digital multimeter to collect data from a 2014 Chevrolet corvette acceleration pedal sensor (GM 23418313). The data will be used to generate a calibration curve.

1. apply the concepts and definitions of calibration, static sensitivity and zero offset for an analog sensor
2. operate laboratory multimeter and wiring diagram to inspect and record position sensor signal output
3. construct circuit and operate laboratory power supply to power sensor
4. determine appropriate statements of uncertainty for multimeter measurements

Background

Consult the user manuals for the multimeter. A wiring diagram for a similar sensor is provided. The pinout for the connector is also provided. A diagram of the system setup is shown in the background document.

Collaboration

This challenge can be accomplished as an individual or as a group of two. All individuals must complete and submit a challenge report individually. Data collection can be shared between partners, but data analysis and discussion must be completed individually.

Setup Notes

The accelerator pedal position unit contains two separate sensors in a single package (APP1, APP2). This challenge will only require wiring the first sensor (APP1) to the breadboard. The remaining three wires are for the second sensor and will not be used in this challenge.

Activity 1 – Construct circuit

Connect the sensor wires to the breadboard posts as shown in the image. Use the banana plug wires to connect the power supply to the breadboard. Make sure to connect ground (0v) to pin A and 5v to pin C. The sensor signal will be measured with the multimeter from pin B with respect to ground. The power supply should be set to 5v and the current limit should be set to a low value (most of the way CCW).

With the power supply turned off and the pedal not depressed, measure the resistance between pin A and pin B while the pedal is not depressed. Depress the pedal and measure the resistance between pin A and pin B again. Repeat the process for pins B and C and pins A and C. Record the resistance values (6 values total).

Activity 2 - Use multimeter to collect static calibration data

To generate data for the calibration process, collect voltage measurements from the output signal corresponding to a range of known inputs. ANSI test standard S51.1 describes collecting a series of static calibration data points as the independent variable is increased through the intended operating range and repeating the same measurements as the variable is decreased.

Depress the pedal through a range of known inputs while recording the corresponding output signal voltages. A suggested procedure for determining the known input angle is to measure the vertical position of a reference point on the moving pedal with respect to the fixed base. Trigonometry can be used to calculate the pedal angle. Record the measured distances, the calculated angle, and the output voltage for each position. Repeat the process while increasing the input and decreasing the input to collect up-cycle and down-cycle data sets.

Activity 3 – Generate Calibration Curve

Plot the collected calibration data with the known reference data on the x axis and the measured voltages from the sensor signal on the y axis. Show both sets of calibration data on the same figure, and indicate which points come from increasing input (up-cycle) and decreasing input (down-cycle). Use linear least squares regression to calculate the static sensitivity and zero offset of the resulting calibration curve. The required equations are given in the background document

Activity 4 –Determine Goodness of Fit

Calculate the correlation coefficient using the equations in the background. How does your r value compare to your peers?